



Using Poultry Litter as Fertilizer

Hailin Zhang

Waste Nutrient Management Specialist

Douglas W. Hamilton

Waste Management Specialist

James G. Britton

Area Poultry Specialist

Oklahoma Cooperative Extension Fact Sheets
are also available on our website at:
<http://www.osuextra.com>

Poultry litter is an excellent, low cost fertilizer if used properly. Land application of litter returns nutrients and organic matter to the soil, building soil fertility and quality. In addition to the micronutrients, N, P and K, poultry manure contains calcium, magnesium, sulfur, and other micronutrients.

Land application of poultry manure should be managed to recycle plant nutrients rather than for disposal. Increasing environmental concerns about agricultural non-point source pollution make it imperative that poultry farmers use poultry litter in the manner most beneficial for the environment – both on and off the farm. Steps to proper litter management are:

1. Determine crop nutrient requirement based on a realistic yield goal.
2. Determine the nutrient content of litter.
3. Determine the fraction of litter nutrients available to the crop in the first year of application.
4. Determine litter application rate to supply crop nutrient needs.
5. Determine supplemental nutrients needed for maximum crop growth.

These steps will assure that the proper amount of litter is applied. Avoiding excess litter application protects water quality.

Crop Nutrient Requirement

Poultry litter should not be applied to soil beyond the limits of the growing crop's nutrient needs. This will ensure efficient use of manure nutrients and minimize nutrient leaching or runoff into the surface and ground water systems. Any soils scheduled to receive poultry litter should first be tested to determine fertility level. Periodic soil testing is recommended to monitor the nutrient supplying capability of the soil. Fertilizer recommendations based on soil test results are the only reliable way to determine the crop nutrient requirement.

Soil testing is available through OSU Soil, Water and Forage Analytical Laboratory in Stillwater, as well as, a number of commercial laboratories. Crop nutrient needs are given in the interpretations and requirements section of the soil test report. You can also determine crop nutrient needs

using Extension Facts F-2225, OSU Soil Test Interpretations. Contact the local extension office for instructions and supplies for taking and submitting soil samples.

Fertilizer Value of Litter

The nutrient content of poultry litter varies quite a bit. Fertilizer value depends on the type of birds, age of the litter, and litter moisture content. It is always a good idea to take a sample and test the litter for nutrients prior to cleaning out a house. Use the test results to calculate how much litter to apply to fields.

Litter samples should be representative of the house or litter pile in the storage. See OSU Extension Facts F-2248, Sampling Animal Manure for Analyses for details of manure sampling. Results are reported as pounds of nutrient per ton on a "dry" and "as is" basis. "As is" means the amount of nutrients per ton at the moisture content when the sample was taken. Normally, "as is" numbers are used for rate calculation. Table 1 shows "as is" fertilizer values from a number of studies. As you can see, the values cover quite a range. Much of the variability is due to moisture content. You can overcome the moisture factor by using the "as is" values and calibrating spreading equipment based on weight of material actually spread.

Table 1. "As is" Broiler Litter Fertilizer Concentrations.

<i>Source</i>	<i>Total N</i>			<i>P₂O₅</i>	<i>K₂O</i>
	<i>lbs/Ton</i>				
Arkansas	56	48	36		
Oklahoma	57	62	49		
Missouri	54	26	32		
Delaware	59	64	41		
Alabama	78	74	50		
Georgia	70	30	44		
Tennessee	67	71	47		
Texas	67	62	46		
Average	64	55	43		

Availability of Litter Nutrients to Crops

The values listed in Table 1 are total nutrients in litter. These are not equivalent to nutrients in commercial fertilizer because not all the nutrients listed on a manure analysis report are readily available to a crop in the year of application. Some elements are released when organic matter is decomposed by microorganisms. Nitrogen may be lost to the atmosphere by ammonia volatilization and denitrification, or lost below the root zone through leaching.

Nitrogen availability during the year of application varies greatly and ranges from about 30 to 80 percent. Nitrogen is present in both organic and inorganic forms. Organic Nitrogen must be converted (mineralized) into inorganic nitrogen to become available to plants. The amounts of organic N converted to plant-available forms during the first cropping year after application vary according to environmental conditions and manure handling systems. About 25% to 50% of the organic N becomes available during the year of application. All of the inorganic N, ammonium-N ($\text{NH}_4\text{-N}$) and nitrate-N ($\text{NO}_3\text{-N}$), is readily available to plants. However, if litter is exposed on the soil surface, considerable $\text{NH}_4\text{-N}$ may be released to the air as ammonia (NH_3) gas. Ammonium worked into the soil is subject to nitrification (rapid conversion to $\text{NO}_3\text{-N}$). Nitrate-N is readily available to plants, but if excess water is present, it can be lost through leaching or denitrification (conversion of $\text{NO}_3\text{-N}$ to N_2 gas). Combining inorganic N, and N available from organic N, gives the total N available to crops. This is sometimes called plant available nitrogen, PAN.

Table 2 shows the approximate availability of nitrogen in the first three years after application. Notice that more nitrogen is available for plant use if the litter is incorporated into the soil soon after application. Incorporation reduces ammonia volatilization losses.

Few studies have been done on P and K availability in poultry litter; however, availability is considered to be about 80-100 % of P and K available in commercial fertilizer. In general, 90% availability is assumed when determining an application rate based on P.

Application Rate

Land application rates should be based on the nutrient requirement of the crop. Too little manure application will not provide sufficient nutrients for the desired crop production. Excess nutrients are a waste of resources, resulting in soil phosphorus buildup which may cause water contamination.

Soil testing, litter analysis, and proper estimation of yield goal are necessary to calculate proper agronomic application rates of litter. Develop a manure nutrient management plan

Table 2. Estimated Poultry Litter Nitrogen Availability Based on Application Method.

<i>Year after Application</i>	<i>Surface Application</i>	<i>Soil Incorporation</i>
First Year	50%	60%
Second Year	15%	15%
Third Year	6%	6%

that consumes manure nutrients, then supplement with commercial fertilizers to balance crop needs. Follow the steps in the attached worksheet to calculate application rate. Nitrogen credits should be given to previous years' applications in Step 1b if litter is applied to the same field continuously.

Application Timing

Proper timing of litter application is essential for efficient use of nutrients and pollution prevention. Litter should be applied as near to field crop planting dates and as close to the forage crop growing season as possible. Applying manure outside of crop growth periods decreases nutrient availability, and may increase the risk to environmental quality.

Grasses or pasture offer some flexibility when crop fields are not available. Litter applied during spring provides starter nutrients and releases mineralized nitrogen throughout the growing season. Applying litter in the fall generally results in greater nutrient loss than does spring application, especially if the litter is not incorporated. Early fall application may be desirable to supply nutrients to cool season grasses. Winter application is the least desirable because litter must remain on the soil surface for 3 to 4 months ahead of the crop's active growing period.

Benefits of Application

Fifty pounds of nitrogen per acre is needed to produce one ton of grass forage. This is true whether the nitrogen comes from commercial fertilizer or poultry litter. Poultry litter has been shown to improve the quality of forage, as well as increase yields. Table 3 compares effects of poultry litter and commercial nitrogen fertilizer on the production of Bermuda grass in southeastern Oklahoma. Poultry litter not only increased forage yields but also increased protein content over control and commercial fertilizer plots. Higher yields and protein content at similar rates of litter and commercial fertilizer may result from the fact that litter provides a slow release nitrogen fertilizer, improves soil quality, and reduces soil acidity.

Table 3. Average Forage Yield and Crude Protein Content of Bermuda Grass in Southeastern Oklahoma at Four Nitrogen Treatments.

<i>Treatment</i>	<i>Forage Yield Tons/Acre</i>	<i>Crude Protein %</i>
No N	2.77	8.0
300 lbs/Acre Ammonium Nitrate (96 lbs Total N/Acre)	3.44	8.8
2 Tons/Acre Poultry Litter (approximately 130 lbs Total N/Acre)	3.54	11.4
4 Tons/Acre Poultry Litter (approximately 260 lbs Total N/Acre)	4.82	12.6

Poultry Litter Application Rate Calculation Work Sheet

	<i>Example:</i>	<i>Your numbers:</i>
1a Nutrient needs of crop (lbs/acre) Recommendations based on soil test results and a realistic yield goal.	N = 200 P ₂ O ₅ = 80 K ₂ O = 40	N = P ₂ O ₅ = K ₂ O =
1b Nutrients carried over in last 2 years' applications (lbs/acre) See Table 2.	N = 25 P ₂ O ₅ = 0 K ₂ O = 0	N = P ₂ O ₅ = K ₂ O =
1c Nutrient needs to meet with litter Subtract line 1b from line 1a.	N = 175 P ₂ O ₅ = 80 K ₂ O = 40	N = P ₂ O ₅ = K ₂ O =
2 Total nutrients available in litter (lb/ton) Based on litter analysis of representative sample collected close to time of application.	N = 64 P ₂ O ₅ = 55 K ₂ O = 43	N = P ₂ O ₅ = K ₂ O =
3 Determine available nutrients (lb/ton) Multiply the value in step 2a by availability, 50% for N and 90% for P and K.	N = 32 P ₂ O ₅ = 50 K ₂ O = 39	N = P ₂ O ₅ = K ₂ O =
4a Calculate application rates to supply N, and P₂O₅ needs (tons/acre) Divide values from Step 1c by values from Step 3.	N = 5.5 P ₂ O ₅ = 1.6	N = P ₂ O ₅ =
4b Choose between N or P₂O₅ application rate (tons/acre) Select highest rate in Step 4a to use litter as complete fertilizer. Select lowest rate to maximize nutrient use.	Rate = 1.6 (based on P)	Rate =
5a Determine amount nutrients applied at chosen rate (lbs/acre) Multiply the rate chosen in step 4b by available nutrients in step 3.	N = 51 P ₂ O ₅ = 80 K ₂ O = 62	N = P ₂ O ₅ = K ₂ O =
5b Determine supplemental nutrients (lbs/acre) Subtract the nutrients applied, step 5a from nutrients needed, step 1c. If the difference is negative, enter 0.	N = 124 P ₂ O ₅ = 0 K ₂ O = 0	N = P ₂ O ₅ = K ₂ O =

The Oklahoma Cooperative Extension Service

Bringing the University to You!

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.

Oklahoma State University, in compliance with Title VI and VII of the Civil Rights Act of 1964, Executive Order 11246 as amended, Title IX of the Education Amendments of 1972, Americans with Disabilities Act of 1990, and other federal laws and regulations, does not discriminate on the basis of race, color, national origin, sex, age, religion, disability, or status as a veteran in any of its policies, practices or procedures. This includes but is not limited to admissions, employment, financial aid, and educational services.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Samuel E. Curl, Director of Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Dean of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of 20 cents per copy. 0702